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Process for the cultivation of plants and  
containers for carrying out the process

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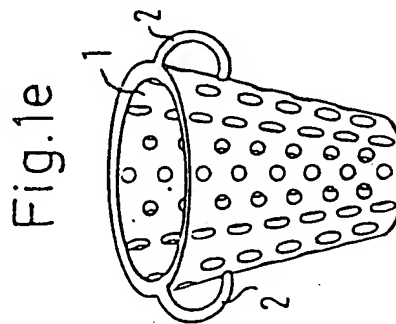
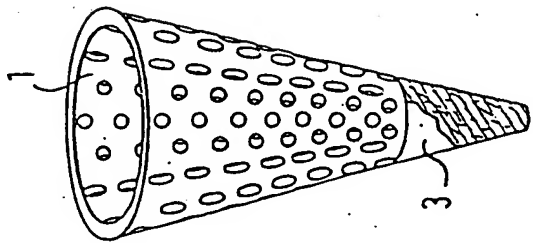
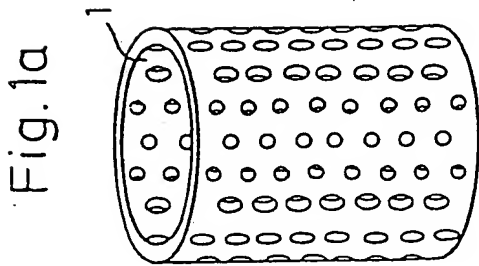
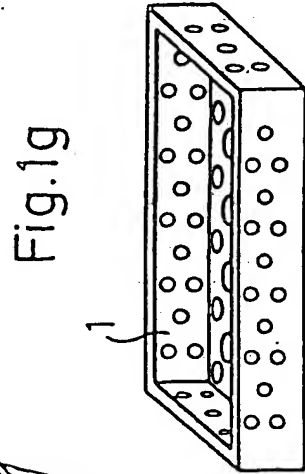
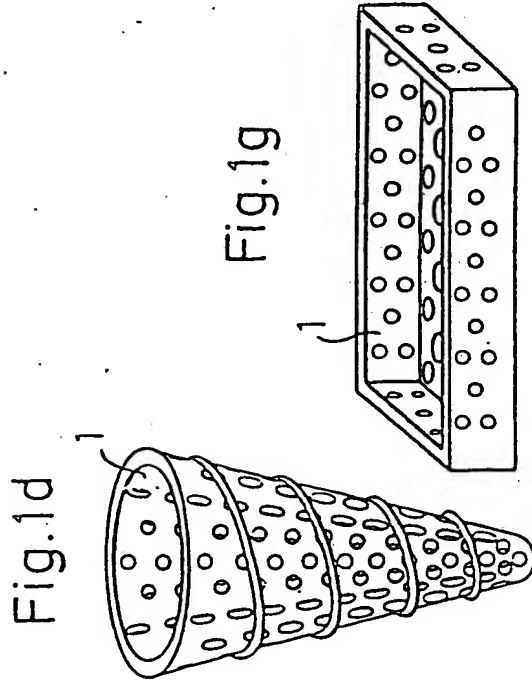
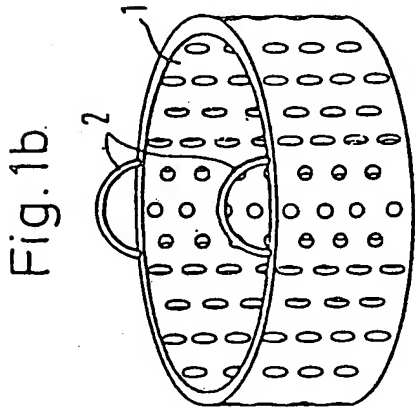
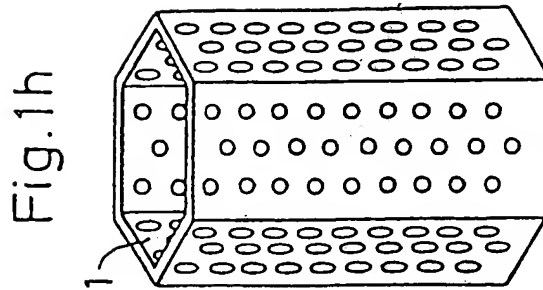
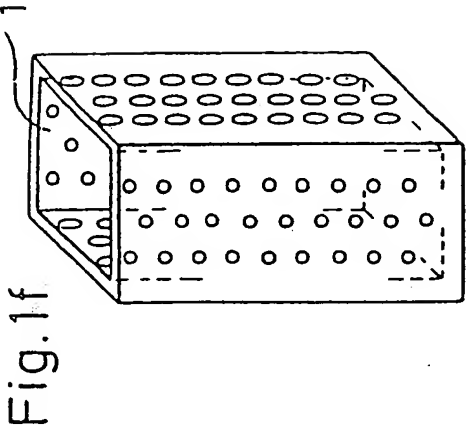


Fig. 2a

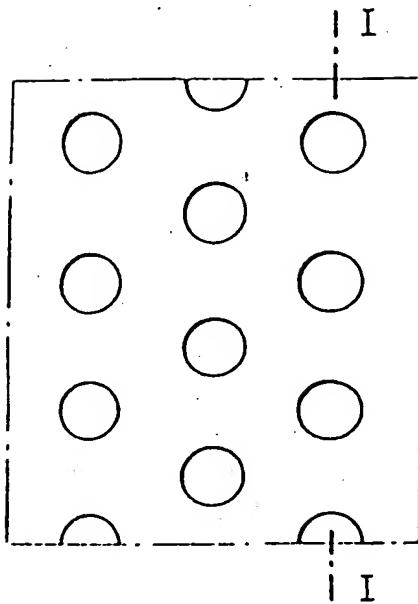


Fig. 2b

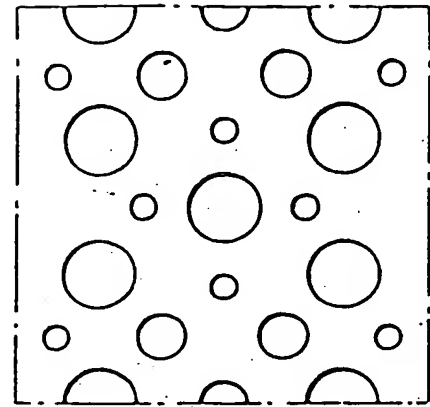


Fig. 3a

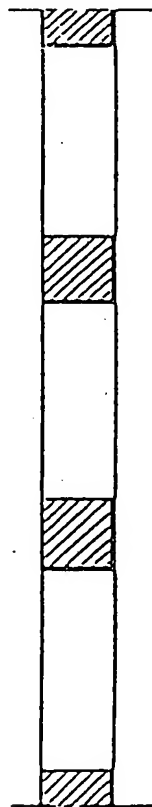


Fig. 3b

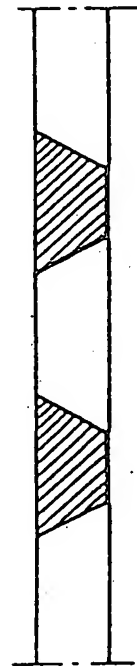


Fig. 4a

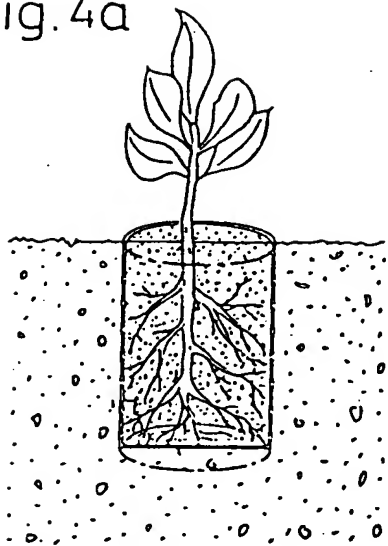


Fig. 4b

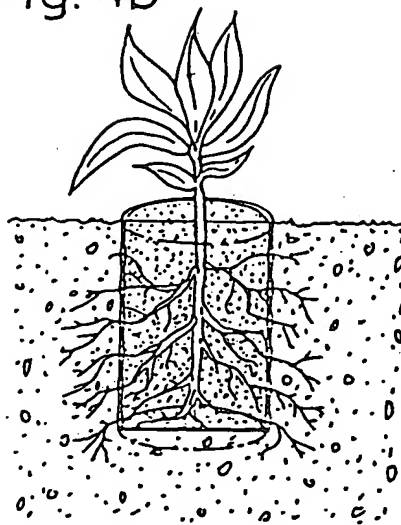


Fig. 5a

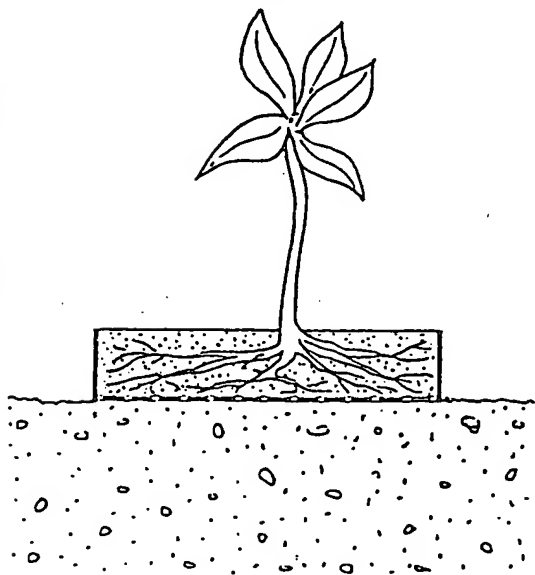


Fig. 5b

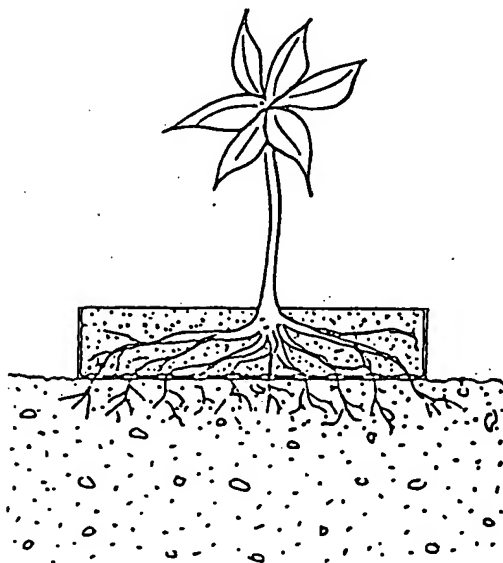


Fig. 6

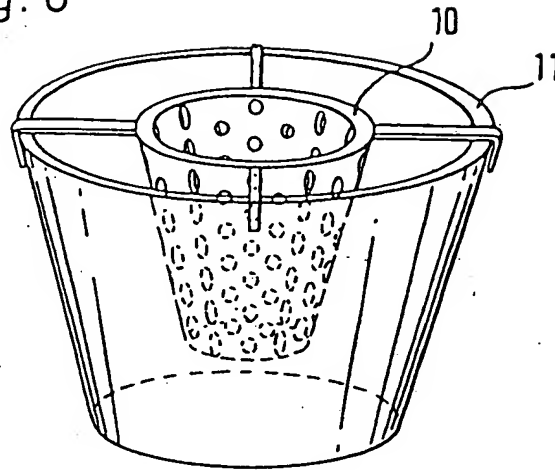


Fig. 7

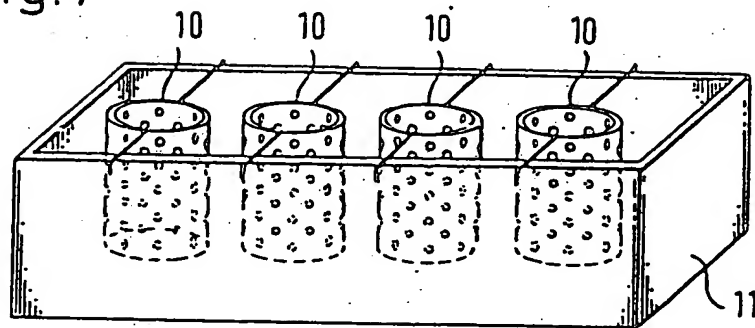
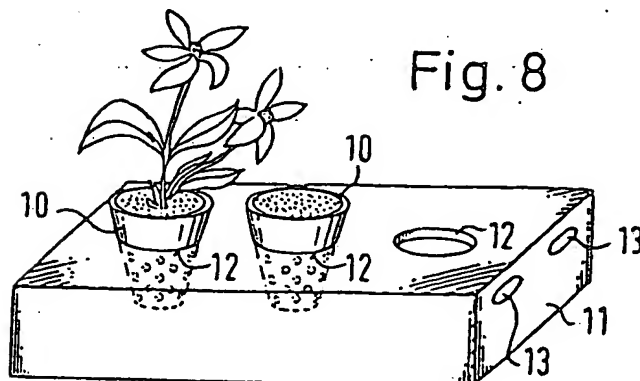


Fig. 8



## SPECIFICATION

Process for the cultivation of plants and containers for carrying out the process

5

*Specification*

This invention relates to a process for the cultivation of plants, to the plants obtained and to a container for carrying out the process.

- 10 Many plants are cultivated in pots or tubs. This applies particularly to many of the decorative and flowering plants. Decorative plants are sometimes also first raised in seedling pots or dishes before they are planted out. The known plant pots are
- 15 similar in volume to the plants and have a diameter of about 100 to 200mm and wall thicknesses of about 2 to 5mm. Special processes for preventing the roots from spreading out in the circumferential direction and containers for carrying out the processes are also known.

- 20 In German Patent No. 953, 393, for example, a plant container is described which consists of wire mesh and a removable covering of synthetic foam surrounding the wire mesh. The purpose of these
- 25 containers is to hold the soil together as a compact basis for growth. As can be seen from the drawing in the said German Patent, the container has the usual size of a flowerpot in relation to the plant.

- 30 In German Offenlegungsschrift No. 2,434,538 a plant pot is described which has a lining of open celled flexible foam. The foam has a thickness of 1 to 10mm and the pots, as indicated at the top of page 8, are ordinary flowerpots available on the market, for example with a diameter of 75 to 90mm or 120 to
- 35 150mm or 180 to 240mm, although pots for larger plants, with a diameter of about 1000mm, may also be used.

- 40 The container described in German Offenlegungsschrift No. 2,434,538 is said to promote exceptionally rapid plant growth, the flexible foam having the function of storing a certain amount of water and air and above all to prevent so-called circling of the roots, which is a commonly known, undesirable phenomenon in which the roots, on reaching the
- 45 wall of the container, continue to grow in a tangential direction without developing effective roots to a sufficient extent. This leads to ageing and drying out of the roots.

- 50 Other plant containers have been described, for example in British Patent No. 1,186,730 and German Offenlegungsschrift No. 1,482,977. The plant container described in British Patent No. 1,186,730 has a wall constructed from a mesh of plastics wire or jute, through which the roots can grow unhindered into
- 55 the surrounding soil. The cultivation pot made of synthetic material disclosed in German Offenlegungsschrift No. 1,482,977 has approximately 40 perforations each measuring about 2 x 4mm in its side walls. The roots can already grow through these
- 60 openings during the initial growth phase. The container has to be removed for planting out and has tearing lines to facilitate removal for this purpose so

plants, however, have at least about half the volume of plant raised in it and generally their volume is in the range of 500 to 2000 cc or even substantially higher.

- 70 The disadvantage of using such large containers for growing plants is that it requires the watering, fertilisation and handling of large volumes of soil, and when the plants are subsequently sold in the containers, large masses have to be transported and
- 75 stored, which is often difficult, for example in small flower shops.

- With the increasing world population and attendant food shortage, there is a great need to make fallow land suitable for cultivation. Large parts of the
- 80 world are covered with infertile desert, steppes and sand. It has not been possible in the past to cultivate these areas, partly because the soil does not contain sufficient nutrients for the cultivation of plants and partly because the climatic conditions are unsuitable. Many regions of the world, for example, have
- 85 only a comparatively short time of frost which is insufficient for germination, growth and ripening of the plants. There are also many regions where useful plants cannot be grown because the rainfall is
- 90 insufficient and irrigation of the whole area would be too expensive.

- There is therefore a great need for processes with which it would be possible to cultivate plants with normal growth above the soil and with normal yields
- 95 in such a way that the roots occupy only a small volume. There is also a need for a process which would make it possible to use large parts of the earth which today cannot be used for agriculture.

- It is therefore an object of the present invention to
- 100 provide a process by which plants with normal growth above the soil could be cultivated without requiring large volumes of earth for their roots and which would make it possible for large parts of the earth which are now fallow to be cultivated.

- 105 The invention relates to a process for the cultivation of a plant with normal growth above the soil in which the roots of the plant, cutting, seed, bulb or other plant material are surrounded by a container, which is larger than 5l cc, which has an opening in
- 110 the direction of growth of the plant and which is partly or completely perforated, the area of the perforations being from 1.5 to 0.007 mm<sup>2</sup> and at least 10% of the container being perforated, the dimensions of the perforations being such that the
- 115 roots are substantially smaller in relation to the roots of a plant which is grown under the same conditions, but not in such a container the container is partly or completely filled with nutrient substrate and is partly or completely brought into contact with substrate or
- 120 nutrient substrate and/or water optionally by hydroculture and the plant is cultivated.

- The invention also relates to a container for the cultivation of a plant with normal growth above the soil which container has confining walls which are
- 125 partly or completely perforated and an opening in the direction of plant growth, the area of the perforations being from 1.5 to 0.007 mm<sup>2</sup> and the container being

maximum growth of plants above the soil, the roots require a substantially smaller volume of nutrient substrate than has been assumed in the past if the plants are cultivated in small containers. The reason for this is not completely clear but it is assumed that the soil is more fully utilised under these conditions since it contains a substantially larger number of roots per unit volume, and in particular fine roots with root hairs, than soil in which plants are grown by the usual method. It is known that the root hairs excrete certain substances which dissolve the nutrient compounds and thereby open up the soil. Since a large number of root hairs is present in the process according to the invention, more soil is opened up and the soil is therefore more fully utilised.

In the process according to the invention, the plant material, for example the plant with its roots, a seed or a bulb or cutting, is planted in the container which may be partly or completely filled with the usual nutrient substrate such as soil, peat, expanded clay, special compost or agricultural soil. The nutrient substrate may also be mixed with any inert substances, for example sand or granulated synthetic material. Before planting of the seed, bulbs, rooted plants or cuttings, the nutrient substrate may be mixed with fertilisers, soil improvers, herbicides or pesticides. Additional nutrient substrate may be introduced into the container after planting and, if necessary, watered in the usual manner.

The plants may be watered with pure water or with solutions or dispersions containing additives such as soil improving agents, fertilisers, weedkillers or pesticides. The container may now be kept in a special place so long as the seed, bulb or cutting planted in it has not yet germinated or sprouted. It is one advantage of the process according to the invention that at this stage the plants require little space, for example in a greenhouse, and can be kept under controlled conditions until they have rooted or the seeds or bulbs have sprouted.

The containers with the plants or seedlings inside them may also be kept under foil for some time, for example to protect from extreme weather conditions such as frost or excessive sunshine. Many of the present day cultivated plants are sown, for example, and are extremely sensitive to frost at the time of germination. If the process according to the invention is carried out, the early stage of development can take place in the greenhouse if the climatic conditions are changeable.

The plants in the containers can be kept in the greenhouse or some other sheltered place for periods of several days up to several weeks or months, for example 1 to 3 months, preferably 1 to 2 months and most preferably 1 month, depending on the rate of growth, before they are planted out at their final place of cultivation.

The containers carrying the seeds, bulbs or cuttings or possibly already small plants are then taken to the place where the plant is finally to grow to its full size. It has now surprisingly been found that it is not necessary to plant this container with nutrient substrate in ground which is also arable land. In fact,

The container with the plant or seedling inside it can be inserted in normal agricultural land with light or heavy soil or in fallow land or even in agricultural land which has not been worked or in sand, steppe or woodland or in meadows. It has been found that for normal plant growth it is only necessary for the container itself to contain a nutrient substance such as earth or peat.

The containers may be inserted in the ground. They are inserted at the intervals necessary for normal development of the plants contained in them. Containers containing small beet plants or seedlings, for example, would not be spaced at the same intervals as containers for small plants of peach trees, orange trees or rose trees. Once the container has been placed in the ground, all that is necessary for further growth of the plants is to water the containers with the root mechanism in them and fertilise and otherwise treat them. It has been found that it is perfectly sufficient to water only the container and the root mechanism and nutrient substrate inside it. This is a great advantage when opening up dry regions for cultivation since it means that it is unnecessary to water unlimited areas of land. Instead, it is quite sufficient only to water the containers.

The same applies to fertilisation and the treatment with pesticides, weedkillers, soil improvers and the like. This is a great advantage since it is now no longer necessary to treat the whole field or area of cultivation with these substances. It is sufficient to treat only the nutrient substrate in the container together with the root mechanism inside it.

Another advantage of the process according to the invention is that the container with the plant inside may be surrounded by another container. This other container may be partly or completely filled with nutrient substrate or with some other substrate or it may be completely free from substrate and nutrient substrate and the containers containing the plants may either be stood or inserted in these outer containers or suspended inside them. Such an outer container may be completely closed but it preferably has openings at least to correspond to the opening in the direction of plant growth provided in the perforated containers, and these openings in the outside containers may also be somewhat smaller than the openings in the perforated containers containing the growing plants. This has the advantage that if, for example, the containers containing the growing plants. This has the advantage that if, for example, the containers containing the growing plants are funnel shaped or conical, they can simply be inserted in the larger containers. The larger containers may have any shape, e.g. they may be in the usual form of covering pots or troughs or tubs or boxes. The use of the larger containers has the advantage that in many cases it reduces the frequency with which the plants need to be watered. The containers in which the plants are growing may, for example, be suspended in the larger containers, at the bottom of the larger containers may be covered with water which may contain nutrient salts, and

The water in the nutrient substrate for the plants need then only be replenished at long intervals and the plants need not be watered daily. The use of the larger containers, for example in the form of concrete channels, has the further advantage when growing plants in the desert that the quantity of water required can be even further reduced.

The perforated container with the plant or seedling inside it may also be covered with an absorbent material, for example by wrapping such a material round it. The absorbent material used may be absorbent paper of the type normally used for paper handkerchiefs, textile materials, felt or any type of absorbent artificial material such as foam. A material of this kind may be wrapped round the perforated container, for example in the form of a tape. In that case, only the material wrapped round the perforated container need be watered.

A container which has an absorbent material wrapped round it may also be surrounded by a second container, e.g. it may be placed inside such a container. The bottom of the second container may be covered with water or an aqueous solution containing nutrient salts. In that case, frequent watering of the plants is not necessary. Sufficient water and/or nutrients are supplied to the substrate or nutrient substrate inside the perforated container through the absorbent covering.

The container with absorbent material wrapped round it may also be surrounded by a second container in such a manner that the covering and the wall of the surrounding container are tightly joined together and the bottom of the surrounding container may be covered with water. The surrounding container may, for example, have perforations at the side for the introduction of water. In that case, it is necessary to water the plants even less frequently. Several plants may be cultivated in this way in a single container. This has the advantage that the plants require very little care and attention and yet thrive well.

The wrapping round the container may also be connected to a source of water through a wick or some other absorbent material, as indicated above.

It has surprisingly been found that the time required for growth of plants cultivated by the process according to the invention is generally the same as that required for plants cultivated under normal conditions. This was a surprising finding and not to be expected; rather it was to be expected that since the plants have a smaller root volume or packet, they would grow more slowly than normal plants in which the roots can spread out freely.

The process according to the invention also makes it possible for those areas to be cultivated where the climate allows for only relatively short periods of growth and ripening of the plants. For example, in regions where severe frost prevails, the plants may be started in a greenhouse, e.g. for one or two to three months, and when they have reached about half of their normal growth they can be planted out. In this way it is possible to grow useful plants even in those regions where their cultivation has in the past been impossible because of climatic conditions such

For cultivating these regions, the plants may first be raised by the process according to the invention and then removed from their containers when they have reached half their final size and planted out in the field where they continue to be cultivated. This method of carrying out the process according to the invention would be particularly advantageous in regions of extreme climatic conditions. The process according to the invention has the great advantage of being very versatile and adaptable to local conditions. It has the further advantage that the sowing or the planting of cuttings can be carried out by experts and the growth and development of the plants in their early stages can also be monitored by experts. It is particularly in this stage of their development that plants are often delicate while when they have reached a certain size they become more sturdy and less liable to be damaged. With the process according to the invention, the plants may first be planted by experts and observed and watched during their first weeks of growth by experts. This has the advantage that fewer plants die and the plants are distributed more uniformly in the field.

In many useful plants which are grown from seed, the difficulty frequently arises that not all of the seeds take and the fields are therefore sown too thinly or too densely, partly also due to climatic conditions. If the fields are densely sown, the plants must be thinned out, which is an expensive process. If they are too thinly sown, the yield is too low. These difficulties are overcome by using the process according to the invention.

The container used for cultivating the plants may have any shape and size. The size must be chosen according to the normal size of the plants when they have reached full growth and must enable the plants to reach maximum growth. The containers are larger than 51 cc and are generally in the region of from 51 cc to ca. 100 litres although they may also be larger. Large containers are generally used for trees, e.g. for planting lemon or orange trees, but smaller containers would generally be used, e.g. 250 cc 500 cc or several litres.

The invention will now be described with reference to particularly preferred embodiments given by way of example and illustrated schematically in Figures 1 to 5.

Figures 1a to 1h illustrate examples of containers for carrying out the process according to the invention;

Figures 2a to 2b are greatly enlarged top plan views showing a part of the wall of the containers of Figures 1a to 1h;

Figures 3a and 3b are greatly enlarged sections through Figure 2a taken on the line I-I;

Figures 4a and 4b are schematic representations of the container of Figure 1a containing a plant and embedded in the soil;

Figures 5a and 5b are schematic representations of a flat container containing a plant and placed on the ground; and

Figures 6, 7 and 8 show containers according to the invention surrounded by a further container.

The drawings will now be described in more

the containers according to the invention. The container has an opening 1 in the direction of the plant. This opening 1 may have any form and it may also take up one side of the container or, it may take up only part of one side. The opening may have any shape and it can be adapted to the shape of the container.

The containers may also take any form, for example they may be in the form of a cylinder (Figure 1a), and dish (Figures 1b and 1g), a funnel (Figure 1c), a thimble (Figure 1d), a cube (Figure 1f), a truncated cone (Figure 1e) or a polygon (Figures 1h). The containers may be elongated or flat, according to the particular requirements of the locality in which they are to be used. Elongated containers, for example, are used where communication is to be established with the ground water. Flat containers are used where there is virtually no ground water, as, for example, in deserts or other regions of scarce rainfall.

The containers may have grips (2) at the side for easier handling or they may be provided with a closed chamber 3 at the bottom which may be filled with a heavy material such as metal to weight them down, as indicated in Figure 1c. It is not necessary to fill the entire volume of the container with nutrient substrate, and the container may have additional chambers which can be filled with substances of differing densities to balance the weight of the container so that if the containers are deposited mechanically, for example, if they are released from aircraft, they will always land on the ground in the correct position and be correctly embedded in the ground.

The containers may also have a spiral thread on the outside as indicated in Figure 1d. This thread may be made of any material and preferably consists of a rigid or hard band or strip of metal or synthetic material fixed projecting from the container. The path of this thread is similar to that of a screw thread and facilitates insertion of the container in the ground or earth.

The containers illustrated in Figures 1a to 1h may be manufactured from any material. They may be self-supporting or not. If they are not self-supporting, they may be provided with reinforcements to increase their rigidity. The container may also be in the form of a flexible bag which is not self-supporting although the containers are preferably self-supporting. They should be resistant to corrosion, at least during the growth period of the plants.

The containers may be manufactured from, for example, synthetic material or metal. Containers manufactured from stainless steel foils and particularly nickel foils are preferred. The containers may also be manufactured from several materials, e.g. one part of the container may be made of a synthetic material and another part of steel sheet or foil. Preferred materials for the containers are metal gauzes and perforated sheets of metals, in particular steel, nickel, and nickel alloys.

Among the synthetic materials, all those which are

It is an essential feature of the present invention that the containers are perforated. They may be perforated over their whole surface although it is sufficient to perforate only part of the surface. For example, the top edge or lower edge of the container may be unperforated. It is, however, generally advisable to perforate the entire side walls and bottom walls of the containers. In a container such as that illustrated in Figure 1b, for example, it is possible to have only the lower wall of the container perforated and manufactured from nickel foil or steel gauze while the side wall may be formed by a ring of unperforated synthetic material.

The size of the perforations is determined by the size of the roots and is in the range of 1.5mm<sup>2</sup> to 0.007mm<sup>2</sup>.

If the perforations are circular, their area is in the range of 0.785mm<sup>2</sup> to 0.0785mm<sup>2</sup> when their diameter is in the preferred range of 1.0 to 0.1mm. It has been found that if circular perforations have a diameter of approximately 0.1mm, even the finest roots are unable to grow through the containers whereas if the perforations have a diameter of approximately 1.5mm, too many roots grow through the container. Circular perforations preferably have a diameter in the range of 0.1 to 0.6mm and most preferably from 0.1 to 0.3mm. In the process according to the invention, it is essential that no roots or only fine roots should grow through the wall of the container. The container may also have perforations of differing diameters and the perforations may be arranged as desired.

The perforations in the containers may have any form, for example they may be round or circular, oval, triangular, square or polygonal or in the form of slits. If they are slits, their maximum length is approximately 3mm and their maximum width approximately 0.5mm. This corresponds to an opening area of 1.5mm<sup>2</sup>.

The perforations are, however, preferably round or circular with diameters in the range of 0.1 to 1.0mm.

In the enlarged views of the container walls shown by way of example in Figures 2a and 2b, the perforations in Figure 2a all have the same diameter whereas in Figure 2b the perforations vary in size. In the embodiment illustrated in Figure 3a, the perforations are in the form of straight prisms whereas in the embodiment of Figure 3b they taper in the form of cones.

The thickness of the container wall depends on the nature of the material used for the container and may be, for example, from 0.01mm to 0.5mm in the case of sheet metal walls, and the preferred wall thicknesses are 0.01, 0.05 and 0.1mm.

It is generally preferred for reasons of economy and for the purpose of aeration and watering to make the walls as thin as possible.

To ensure adequate water supply, it is sufficient for most plants if at least 10% of the surface area of the container wall is taken up by perforations, although the perforations may also occupy a substantially larger proportion of the container wall, for

area of the container wall.

Figure 4a shows a container which is perforated on all sides and inserted in the earth or substrate up to its upper opening. The perforations of the container wall are so small that even fine roots cannot grow through them but they ensure sufficient aeration and supply of nutrient from outside. The supply of nutrient may also be from the inside. In the embodiment shown in Figure 4b, the container is again perforated on all sides and inserted in the earth or substrate right to the top as in Figure 4a but the perforations are in this case larger so that fine roots can just grow through them but no main roots can develop on the outside.

In the embodiment shown in Figure 5a, the container is mainly perforated only at the bottom and is placed on the surface of the ground. The diameter of the perforations is chosen so that even fine roots cannot grow through but supply of air and nutrients from outside is ensured. Nutrients may also be supplied from inside. The container is similar to that shown in Figure 1g except that only the bottom is perforated. The embodiment illustrated in Figure 5b is similar to that of Figure 5a except that the perforations are larger so that fine roots can grow through them.

In the embodiment illustrated in Figure 6, container 10 according to the invention is freely suspended in an outer container 11. The bottom of container 11 may be covered, e.g. with water, and communication between this water and the nutrient substrate in container 10 may be established through a wick or other absorbent material (not shown).

In the embodiment illustrated in Figure 7, several containers 10 for the cultivation of plants are arranged inside a container 11. The containers 10 stand on the bottom of the container 11 but they may also be freely suspended in container 11. The container 11 may be filled with substrate or nutrient substrate or it may be empty or the bottom of container 11 may be covered with water and/or fertiliser.

In the embodiment illustrated in Figure 8, the containers 10 for the cultivation of plants are inserted in a container 11 which has openings 12 on its upper surface. These openings are somewhat smaller in diameter than the opening in the direction of plant growth provided in container 10. In the embodiment shown in Figure 8, the containers for the cultivation of plants can easily be inserted in the container 11 and removed from it. Container 11 may have slits 13 or larger openings in a side wall for the introduction of water.

## 55 CLAIMS

1. A process for the cultivation of a plant with normal growth above the soil in which the roots of the plant, cutting, seed, bulb or other plant material are surrounded by a container, which is larger than 51 cc, which has an opening in the direction of growth of the plant and which is partly or completely perforated, the area of the perforations being from 1.5 to 0.007 mm<sup>2</sup> and at least 10% of the container

being such that the roots are substantially smaller in relation to the roots of a plant which is grown under the same conditions, but not in such a container, the container is partly or completely filled with nutrient substrate and is partly or completely brought into contact with substrate or nutrient substrate and/or water optionally by hydro-culture and the plant is cultivated.

2. A process as claimed in claim 1 in which the container is partly or completely filled with nutrient substrate, the plant with its roots or the seed, bulb or cutting is inserted, additional nutrient substrate is optionally added and the plant is optionally watered and the container together with the plant material is subsequently inserted in or placed on substrate and/or nutrient substrate.

3. A process as claimed in claim 2 in which the container is filled with soil, special soil, peat, expanded clay or a mixture of any of these materials as nutrient substrate in open ground.

4. A process as claimed in claim 1 in which, before the container is inserted in substrate and/or nutrient substrate and until the plant or cutting begins to grow or the seed or bulb begins to sprout, the container is kept in a greenhouse under controlled conditions.

5. A process as claimed in any of claims 1 to 4, in which the container containing the plant material is inserted in normal, heavy or light arable soil, in fallow ground, in woodland, meadow, heath, steppe land, tundra or desert or in dunes or other sandy regions.

6. A process as claimed in any of claims 1 to 5 in which the diameter of the perforations is such that not roots can grow through the perforations.

7. A process as claimed in any of claims 1 to 5 in which the diameter of the perforations is such that only fine roots can grow through the perforations.

8. A process as claimed in any of claims 1 to 7 in which the perforations are circular and have a diameter of 0.1 to 1.0 mm.

9. A process as claimed in claim 1 in which 10 to 90% of the container is perforated.

10. A process as claimed in any of claims 1 to 9 in which a perforated container is used which is in addition surrounded by at least one other partially closed container.

11. A process as claimed in claim 10 in which the bottom of the closed container is covered with water or with a solution containing nutrient salts, and the substrate or nutrient substrate inside the perforated container is connected with the water or with the aqueous solution containing nutrient salt by a wick.

12. A process as claimed in any of claims 1 to 11 in which a perforated container is used which is in addition surrounded by another, partially closed container, and the space between the perforated container and the surrounding container is partly or completely filled with substrate and/or nutrient substrate and the plant is cultivated.

13. A process as claimed in claim 1 substantially as herein described.

14. A process as claimed in claim 1 substantially as herein described with reference to the accom-

15. A container for the cultivation of a plant with normal growth above the soil which container has confining walls which are partly or completely perforated and an opening in the direction of plant growth, the area of the perforations being from 1.5 to 0.007 mm<sup>2</sup> and the container being larger than 51 cc.

16. A container as claimed in claim 15 in which the perforations are in the form of slots or are round, circular, oval, triangular, square or polygonal.

17. A container as claimed in claim 15 in which the perforations are circular and have a diameter of 0.1 to 1.0 mm.

18. A container as claimed in any of claims 15 to 17 in which the perforations are tapered in the form of cones.

19. A container as claimed in any of claims 15 to 18 which is in the form of a funnel, a sleeve, a bag, a cube, a rectangular parallelepiped or a polyhedron.

20. A container as claimed in any of claims 15 to 19 which is manufactured from a woven metal or synthetic material, perforated sheet metal or perforated synthetic material.

21. A container as claimed in any of claims 15 to 20 in which part of the container is manufactured from unperforated metal or synthetic material and another part from perforated metal or synthetic material.

22. A container as claimed in any of claims 15 to 21 at least 10% of which is perforated.

23. A container as claimed in claim 22 from 10 to 90% of the surface of which is perforated.

24. A container as claimed in any of claims 5 to 23 which is self-supporting.

25. A container as claimed in any of claims 15 to 23 which has reinforcements to increase its stiffness.

26. A container as claimed in any of claims 15 to 25 which is in addition surrounded by at least one other container which is partially closed.

27. A container as claimed in claim 15 substantially as herein described.

28. A container as claimed in claim 15 substantially as herein described with reference to the accompanying drawings.

29. A plant, characterised in that it has been raised by at least one of the processes of claims 1 to 14.